GPS-Aided Location Determination and Navigation

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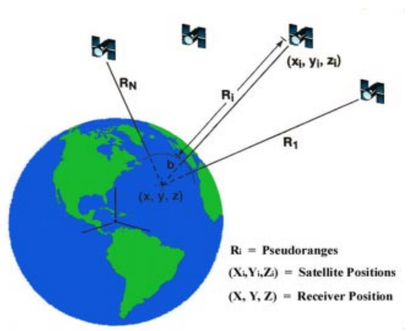
Introduction

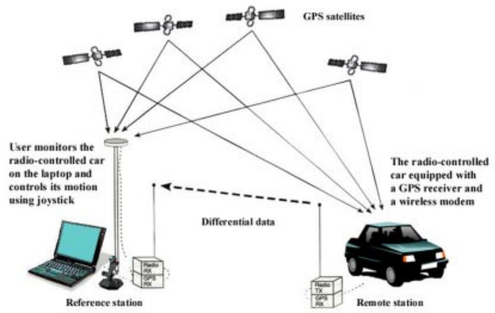


• The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations.

• Minimum of 4 satellites needed to determine the unknown position (x,y,z)of receiver and the clock bias using exact positions of satellites

• Used least square technique to solve the system of equations (one from each satellite) after linearization using Taylor series

Differential GPS

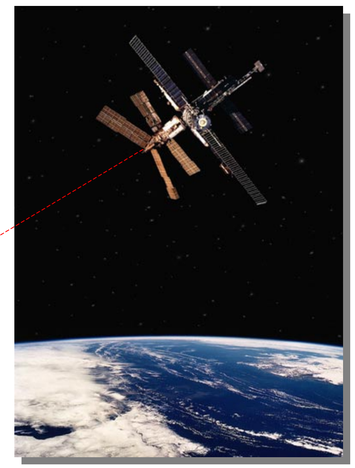


•Differential GPS (DGPS) uses two receivers. The receiver in the known position sends the correcting information to the other receiver in order to improve the accuracy.

• Differential GPS can eliminate the satellites clock uncertainty and errors due to signal transmission by subtracting the positions of the two receivers

• Normal DGPS setup utilizes two receivers with a computer attached to the remote station. The reference station sends the differential data to the remote station.

• In our case, the computer is attached to the reference station and the differential data sent from the remote to the reference station.



Equations

Distance from receiver to satellite given by:

$$\mathbf{P_i^k = \rho_i^k + c\,[dt_i - dt^k] + T_i^k + I_i^k + d_i^k + e_i^k}$$

P_i^k = pseudorange
$\rho_i^k = ||r_i - r^k||$ = distance between satellite and receiver
$= \{(X_i - X^k)^2 + (Y_i - Y^k)^2 + (Z_i - Z^k)^2\}^{1/2}$
r_i = position of receiver
r^k = position of satellite
c = speed of light
dt_i = clock bias in receiver
dt^k = clock bias in satellite
T_i^k = Tropospheric correction
I_i^k = Ionospheric correction
D_i^k = multipath correction
e_i^k = noise correction

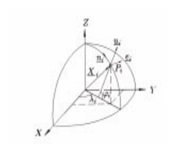
Linearized form of Equation (Using Taylor series)

$$\mathbf{\Delta P_i = -(U_i^k)\,\Delta r_i + C\Delta dt_i + \forall_i^k}$$

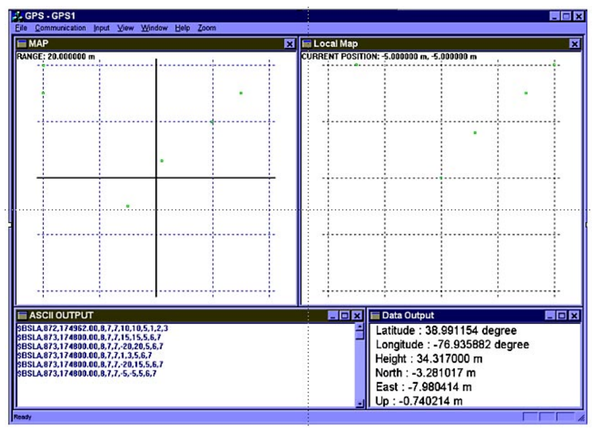
ΔP_i = observed position – calculated position
(U_i^k) = unit vector from receiver to satellite
Δr_i = actual position – initial estimate
Δdt_i = actual receiver clock bias – initial estimate
$\forall_i^k$ = error terms

Global to Local coordinates transformation

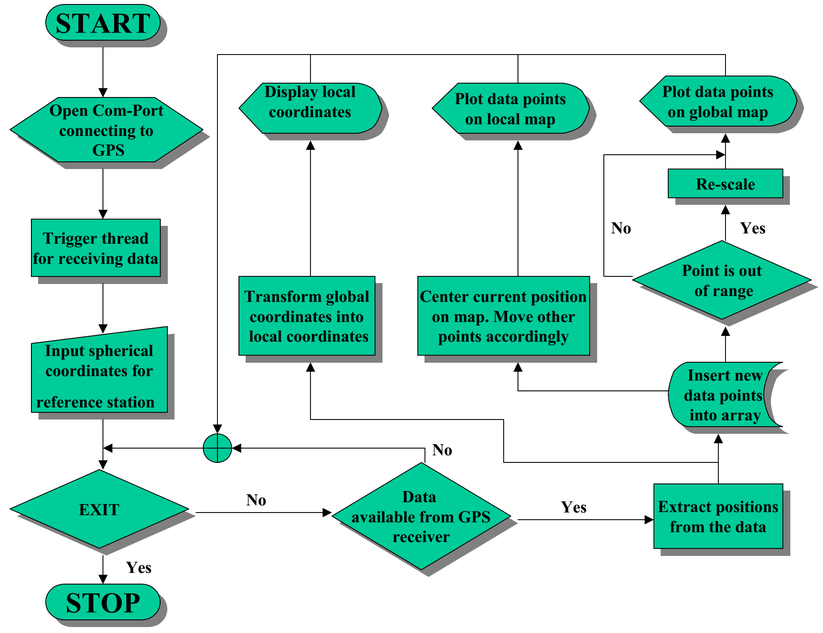
$$\mathbf{n_i} = \begin{matrix} -Sin\Phi_i*Cos\lambda_i \\ -Sin\Phi_i*Sin\lambda_i \\ -Cos\Phi_i \end{matrix} \quad \mathbf{e_i} = \begin{matrix} Sin\lambda_i \\ Cos\lambda_i \\ 0 \end{matrix} \quad \mathbf{u_i} = \begin{matrix} -Cos\Phi_i*Cos\lambda_i \\ -Cos\Phi_i*Sin\lambda_i \\ -Sin\Phi_i \end{matrix}$$



Display of Running Program



Flow Chart



Future Applications

GPS-based geographic messaging

- facilitate broadcasting messages to distinct geographical area t hrough the internet for geographically targeted advertising

In farming

- develop robotic farm equipment for less well trained operators t o optimize yield

Mining and heavy equipment

- use unmanned vehicle to explore dangerous terrain where high acc uracy is required
- DGPS will prove useful for such implementation

Aid in sporting activities

- motorized golf carts that follow golfer instead of human caddie